U. S. FOREST SERVICE

RESEARCH NOTE NC-25

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

Folwell Avenue, St. Paul, Minnesota 55101

Seedbed Density Affects Size of 3-0 Green Ash Nursery Stock[1]

ABSTRACT. — Nursery seedbed density of 3-0 green ash, which ranged from 4 to 36 trees per square foot at Carlos Avery Nursery, Forest Lake, Minn., had a marked effect on caliper, height, fresh weight, and percent and amount of plantable stock. The highest number of good-quality trees was produced at a density of 12.5 trees per square foot.

One of the most common broadleaf species used in planting farm windbreaks and field shelterbelts in the prairies of western and southwestern Minnesota is green ash (*Fraxinus pennsylvanica* Marsh.).

Because of serious weed competition and the somewhat droughty conditions in the area, these trees are invariably cultivated for 3 to 6 years to achieve good survival and rapid growth. The stock should be large (mostly 15 to 28 inches high), sturdy, and well rooted, and have good caliper. Past research in the Great Plains (Stoeckeler 1937) has shown that broadleaf stock with a caliper of 4/32 inch or less (at 1 inch above the ground line) often had survivals of 10 to 30 percent less than premium grade stock with a caliper of 7/32 inch or larger.

In spring 1966 the relation of seedbed density of 3-0 green ash to sizes of trees produced was studied at the Carlos Avery Nursery, a Minnesota Division of Forestry nursery near Forest Lake, Minnesota, and about 35 miles north of St. Paul. Thirty lots of stock, 445 trees in all, were measured and weighed. The seed had been hand-sown in beds containing 7 drills spaced 5 inches apart. Bed density ranged from 4.2 to 36.0 trees per square foot. The trees were distributed rather uniformly within, as well as on either side of, the rows selected for lifting. The rows lifted were usually 4 feet long but occasionally only 2 feet.

[1] *Credit is due the Minnesota State Division of Forestry, especially Stan Karp, Superintendent of the Carlos Avery Nursery, and Emil Kukachka, in charge of the Cooperative Forestry Section, for their cooperation on the study; and Archie Cherry, North Central Forest Experiment Station, who measured the trees.*

Physical and Chemical Properties of the Soil

A composite of five soil cores from the 600-foot-long beds containing the 3-0 green ash sample rows showed the following physical and chemical properties: silt plus clay, 16.3 percent; organic matter, 1.5 percent; total nitrogen, 0.056 percent; available nitrogen, 75 pounds per acre; available phosphorus 49 pounds per acre; available potash, 57 pounds per acre; pH, 5.6.

The soil is deemed deficient in total nitrogen, available potassium, and to a lesser degree, in available phosphorus for production of high-quality trees for prairie windbreak planting (Engstrom and Stoeckeler 1941, Stoeckeler and Arneman 1960). Fertilization trials are now under way to improve the broadleaf stock in this nursery so that it can all be shipped as 2-0 stock.

Stand Density Effect on Tree Height, Stem Caliper, and Weight

As the density of the nursery seedling stand increases, the average tree height decreases (fig. 1A). At 5 trees per square foot the average tree height is 25 inches; at 10, about 20 inches; at 15, 16 inches; and at 35 it drops to 11 inches.

Stem caliper of trees is used in most public nurseries in the Great Plains to sort trees into plantable or cull grades. In the Northern Great Plains, a committee on stock grade standards composed of professional foresters from state and federal agencies and soil conservation district nurseries has set 7/32 inch (at 1 inch above ground line) as the minimum desired stem caliper for windbreak and shelterbelt stock of green ash seedlings. Only densities of 5 to 15 trees per square foot of 3-0 stock would achieve such average caliper at the Carlos Avery Nursery at the *present* level of soil fertility and current irrigation regimes (fig. 1B).

Average green weight per seedling is one criterion of size and quality of trees. A study in the Great Plains (Stoeckeler 1937, Engstrom and Stoeckeler

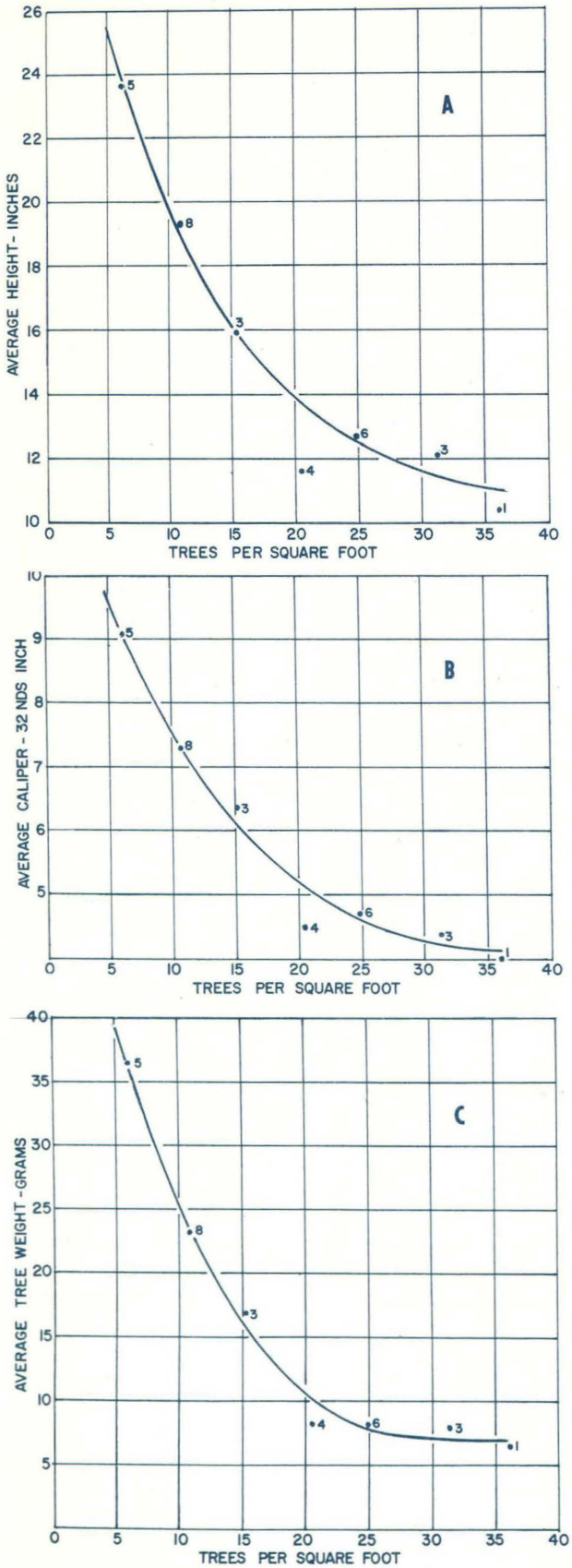

Figure 1.—Relation of stand density of 3-0 green ash to: *A*, height; *B*, caliper; and *C*, fresh weight per tree. The figure at each plotted point denotes number of lots (30 lots in all). Density classes include densities of 2.6 to 7.5 trees, 7.6 to 12.5 trees, etc.

1941) has indicated that green ash trees of 0.4 ounce (equivalent to 11.4 grams) or larger had superior survival and height growth and hence were labeled premium grade. At the Carlos Avery Nursery 3-0 densities of about 5 to 18 trees per square foot achieved this average weight class, but higher densities fared poorly (fig. 1C).

To achieve an average seedling weight of 11.4 grams, the tree must have a caliper of nearly 7/32 inch (fig. 2A). Such a tree would be about 15 inches or more tall (fig. 2B).

All trees in this study, regardless of density, were well rooted with many fine rootlets; the top-root ratio (leafless) averaged 0.64 for 30 lots, and ranged from 0.44 to 0.85. Hence, balance was not a problem.

Stand Density Effect on Percent and Number of High-quality Planting Stock

Stands of comparatively low density had the greatest percentage of high-quality stock (i.e. 7/32 inch caliper or over); stands of high density had less than 30 percent high-quality trees (fig. 3). Obviously the task of culling out the poorer trees would be less for the lower densities.

An important criterion of the "best" density is the *number* of high-quality trees (7/32 inch caliper or larger) produced per square foot of bed area. For the 3-0 green ash studied, best density was about 10 to 15 trees per square foot, with the peak at a density of 12.5 trees:

	Trees per sq. ft.
Density	*High quality*
5.0	4.8
7.5	6.6
10.0	8.0
12.5	8.7
15.0	8.4
17.5	7.7
20.0	6.9
25.0	5.1
30.0	3.2
35.0	1.2

Best density in terms of maximum number of high-quality trees for any tree species will, of course, vary by nursery, fertility level, and age class. Under the conditions cited here, densely sown drills of green ash should be thinned the first year to about 12.5 trees per square foot.

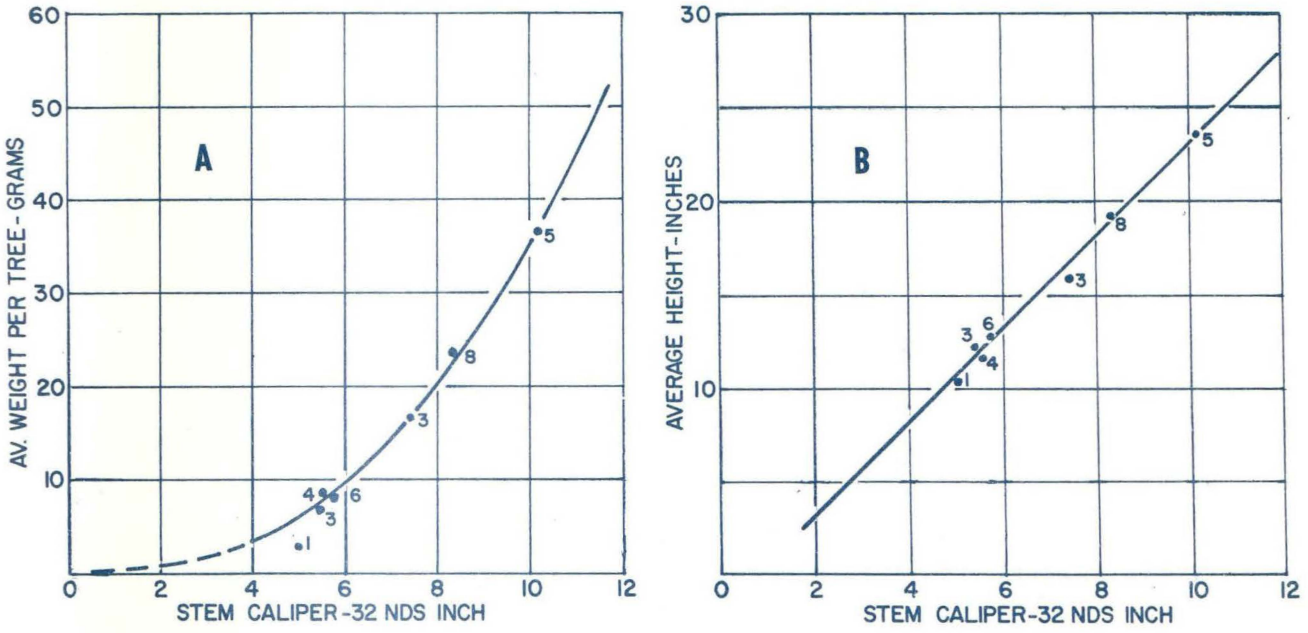

Figure 2.—Relation of stem caliper of 3-0 green ash to: *A*, fresh weight; and *B*, height per tree.

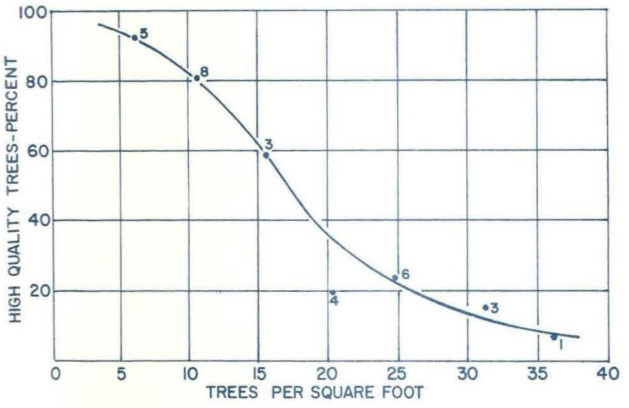

Figure 3.—Relation of stand density of 3-0 green ash to percent of high-quality trees produced (7/32 inch caliper or larger).

Stand Density Effect on Tree Distribution by Stem Caliper

The trees were grouped into three density classes: high, averaging 24.8 trees per square foot; medium, 10.7; and low, 6.1. In the high-density class, 52 percent of the trees were 5/32 inch or less. The respective figures for medium- and low-densities were only 3 and 2 percent; at these low percentages, grading would be a simple matter (fig. 3).

Caliper Versus Height as a Grading Standard

In this study, 51 percent of all trees measured for caliper and height were of 7/32-inch caliper or more, but only 40 percent were at least 16 inches tall. Thus the present Northern Great Plains grading standard for green ash—7/32-inch minimum caliper and 16 inches minimum height—would cause an additional 11 percent or so of the stock measured in this study to be discarded than if the standard were based on caliper size only. For the green ash stock measured here, there was good agreement (i.e., within 2 percent) in two different single criteria of plantability, i.e. between minimum caliper (at least 7/32 inch) and minimum height (at least 13 inches).

Hence, time could be saved by estimating cull on the basis of height alone before lifting the trees. And if 13 inches were considered an acceptable minimum height in subsequent culling, an additional 10 percent or so of the bed run of trees could be saved. In western Oklahoma such short but stocky trees survived well (Engstrom and Stoeckeler 1941).

Literature Cited

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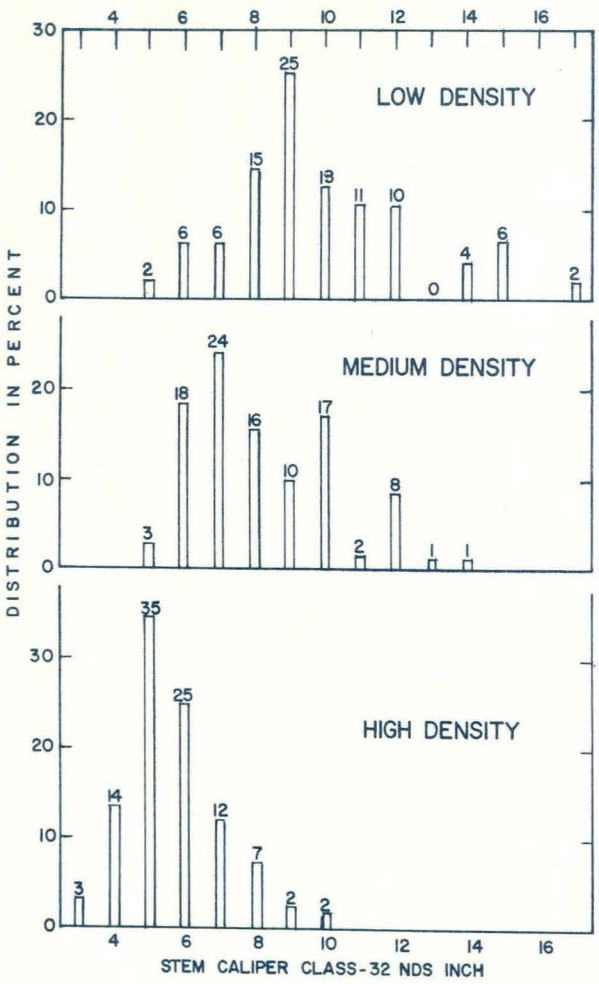

Figure 4.—Distribution of trees by caliper class for three density classes: Low density beds averaged 6.1 trees, medium density 10.7, and high density 24.8 trees per square foot. Figures above each bar are percentages of trees by stem caliper class.

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J. H. STOECKELER
Principal Soil Scientist